MSC-PT-R-68-9
(Revision A)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 4

ANOMALY REPORT NO. 12

(This revision supersedes issue dated February 8, 1968)

DISTRIBUTION AND REFERENCING

This paper is not suitable for general distribution or referencing. It may be referenced only in other working correspondence and documents by participating organizations.

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

September 1968

MSC-PT-R-68-9
(Revision A)

APOLLO 4

ANOMALY REPORT NO. 12

DAMAGE TO RECOVERED MAIN PARACHUTE

(This revision supersedes issue dated February 8, 1968.)

Prepared by: Apollo 4 Mission Evaluation Team

Approved by: George M Low

George M. Low
Manager
Apollo Spacecraft Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
September 1968

DAMAGE TO RECOVERED MAIN PARACHUTE

STATEMENT

Small holes and foreign material were found in the canopy of the recovered main parachute, and the risers and suspension lines were damaged.

DISCUSSION

Damage charting of the main parachute (fig. 1) revealed numerous, small burn holes, varying from 1/100 to 1/16 inch in diameter, with a few sporadic holes varying from 1/4 to 1/2 inch. The majority of the holes in the first nine (of twelve) rings were approximately circular, whereas some of the holes in the lower three rings were elongated slots. This variation in hole shape from the crown to the skirt indicated that the damage occurred when the parachute was fully deployed.

The two possible causes of the holes in the canopy were ablator material (from the heat shield and/or reaction control engine) and nitrogen tetroxide (reaction control system oxidizer).

Small particles of charred heat shield ablator were heated and dropped onto a nylon cloth sample, and the edges of the burn holes exhibited a crustiness similar to those found in the canopy. Because the engine ablator materials are similar to the heat shield ablator, tests using engine ablator were not conducted. If ablator particles had struck the parachute, some particles would have been fused to the nylon. Only a few particles were fused; therefore, hot ablator particles were not a major cause of the damage.

An orange vapor, caused by the dumping of approximately 10 pounds of residual nitrogen tetroxide, was observed escaping from the thrusters while the command module was on the main parachutes. The cloud reportedly extended 2 to 3 riser lengths above the parachute and was about twice as large as the canopy.

A sample piece of nylon cloth was exposed to concentrated liquid nitrogen tetroxide and then rinsed with water. Holes were produced that were very similar to those found in the flight-damaged parachute (figs. 2 and 3).

Chemical analyses of numerous yellow spots found on the parachute risers and suspension lines (figs. 4 and 5) yielded positive identification of nitrates, nitrites, and nitroso- compounds, which would be expected from oxidizer.

The breaking strengths of the most severely degraded samples of the suspension lines ranged from 430 to 670 pounds (nominal rated strength is 650 pounds). The breaking strength of riser material ranged from 7800 to 8100 pounds (rated strength is 11 000 pounds). The tensile strength of the cloth tested was 51 to 56 lb/in. (specification is 42 lb/in. minimum).

The debris (fig. 6) in the canopy was paint chips, sand, wood, nylon, aluminum and brass filings, glass, and caulking compounds accumulated during retrieving, handling, and transporting the parachute from the landing site to the contractor's facility.

CONCLUSION

Oxidizer was the major cause of damage to the canopy, risers, and suspension lines.

CORRECTIVE ACTION

For the Apollo 6 mission, sufficient oxidizer was off-loaded to insure that none would be dumped during parachute operation.

For Apollo 7, the oxidizer will not be dumped during the landing sequence. If an abort should be necessary during the launch phase up to 61 seconds, the propellants will be dumped before parachute deployment. For an abort after 61 seconds, the propellants will remain onboard.

For Apollo 8, oxidizer will be off-loaded to insure that a minimal amount will be dumped during parachute operation.

One of the above actions will be taken on subsequent spacecraft.

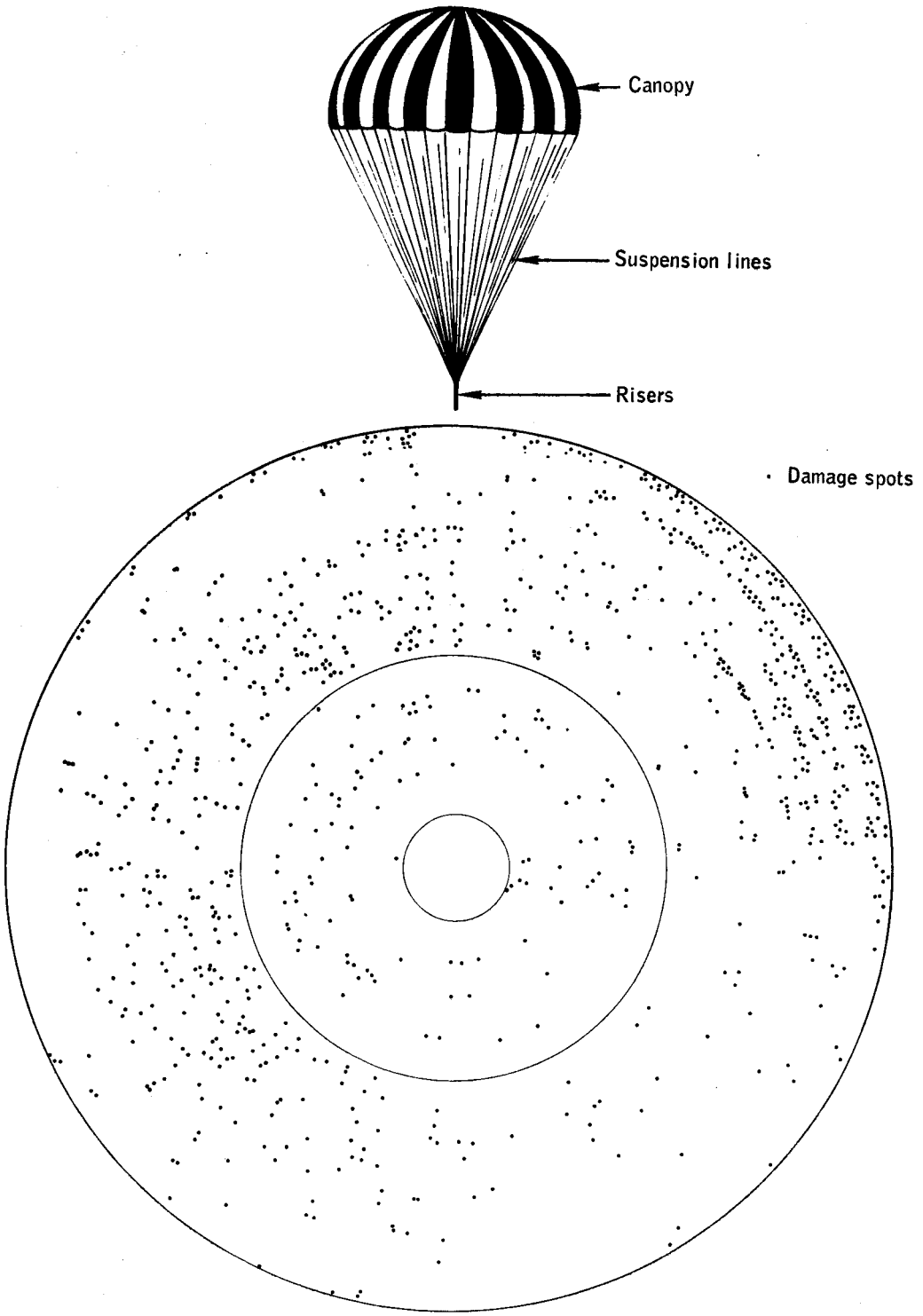


Figure 1.- Hole dispersion pattern.

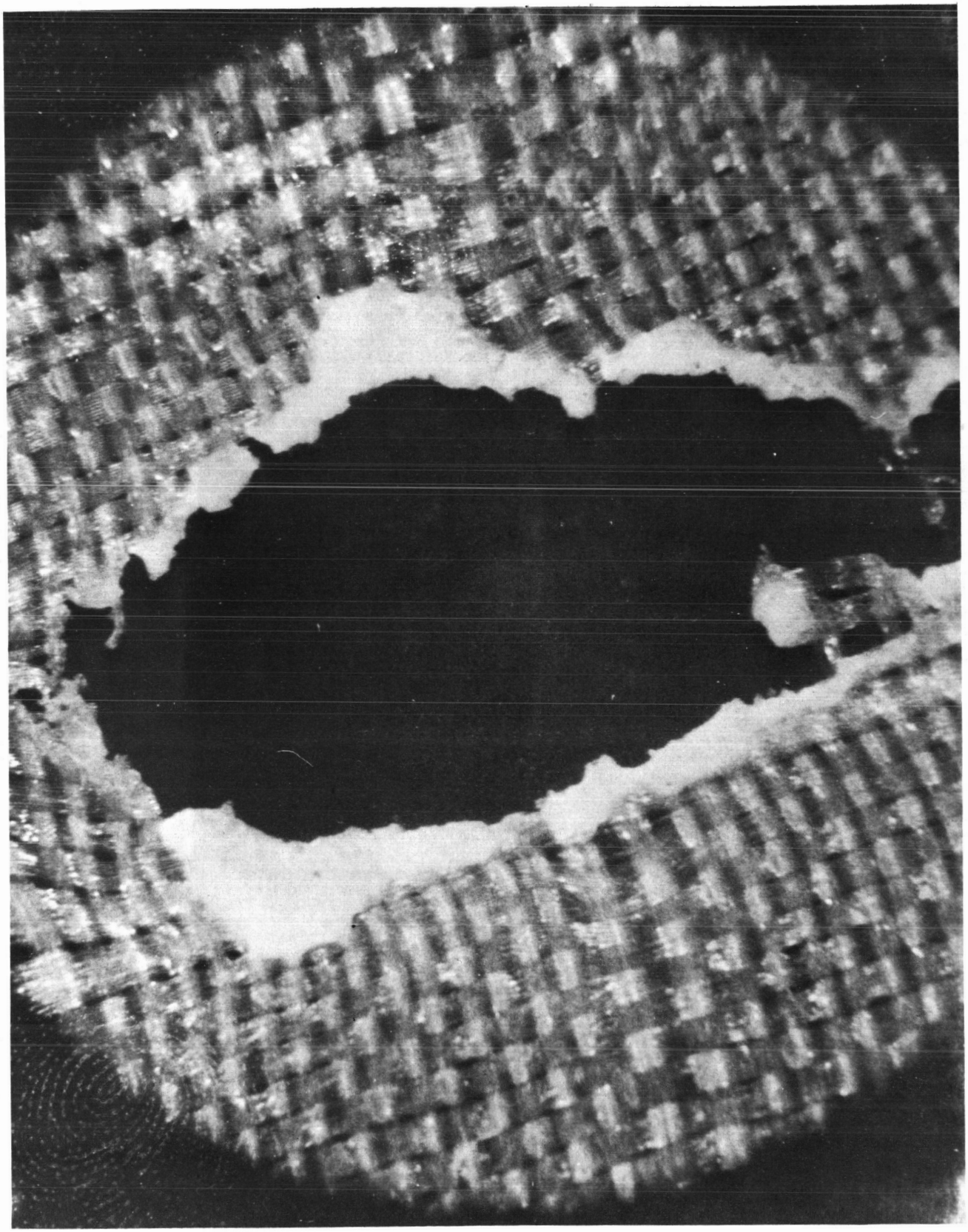
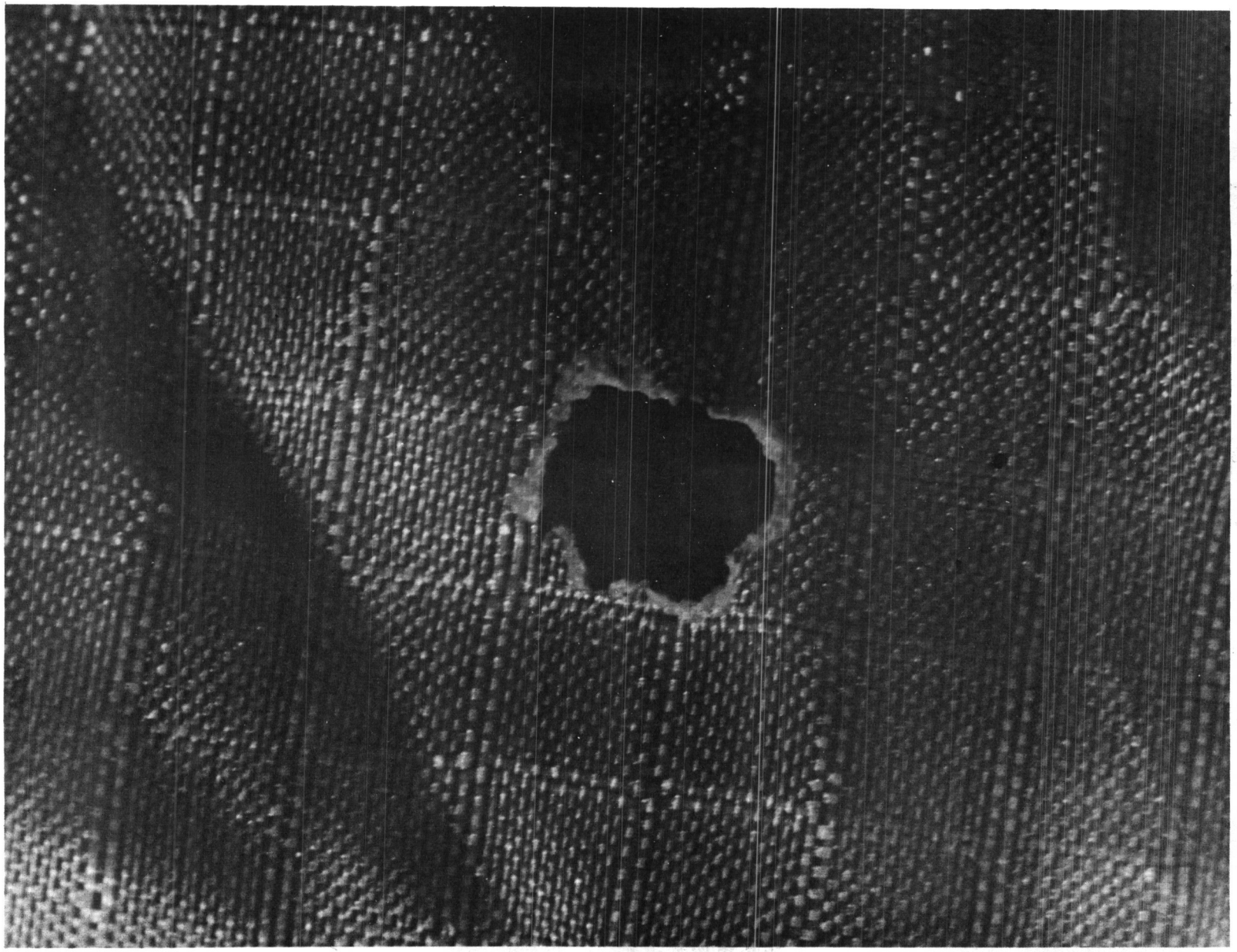


Figure 2.- Microphotograph of hole in parachute canopy.



MSC-188e-69

Figure 3.- Oxidizer damage to nylon.

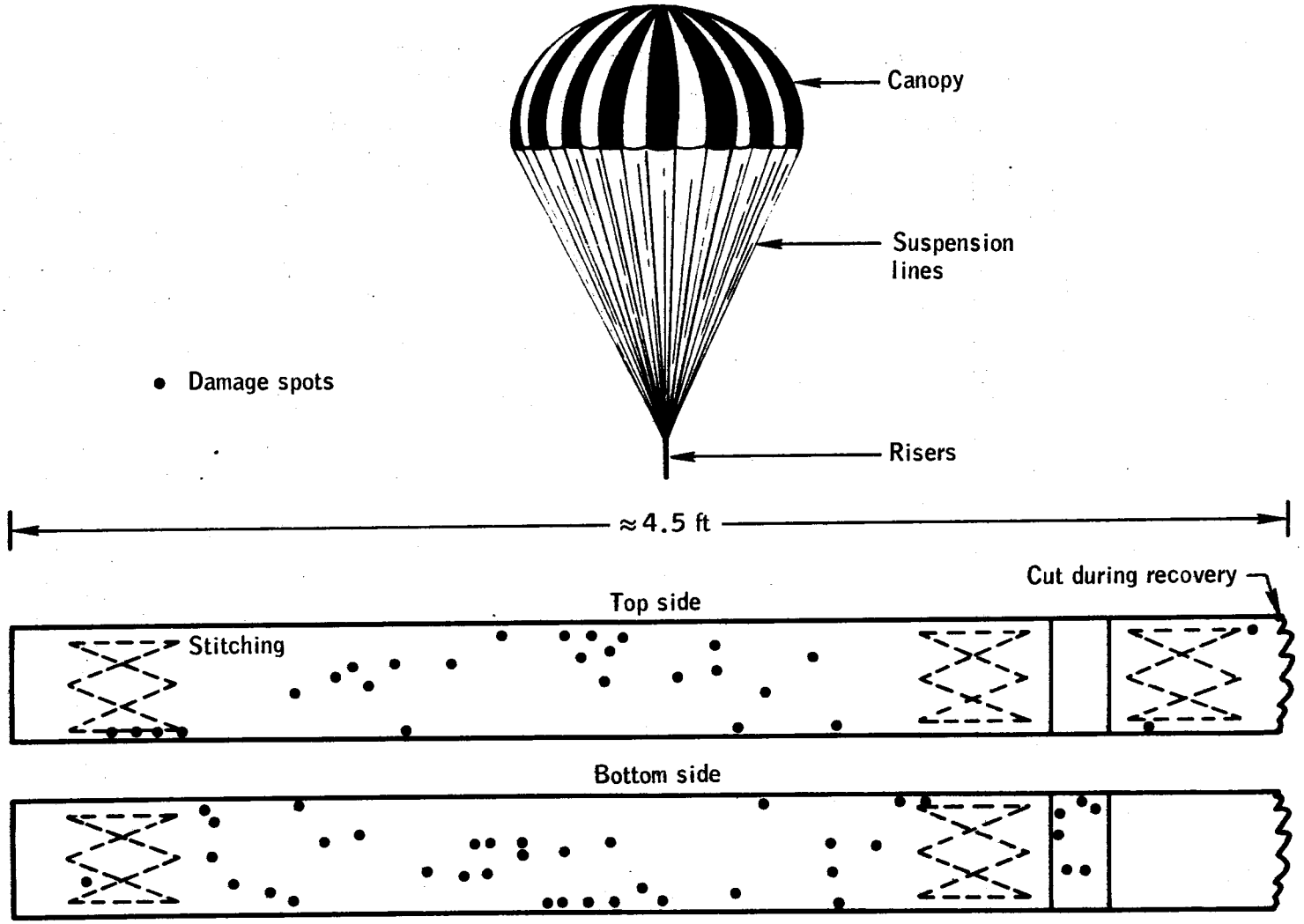


Figure 4.- Typical riser damage.

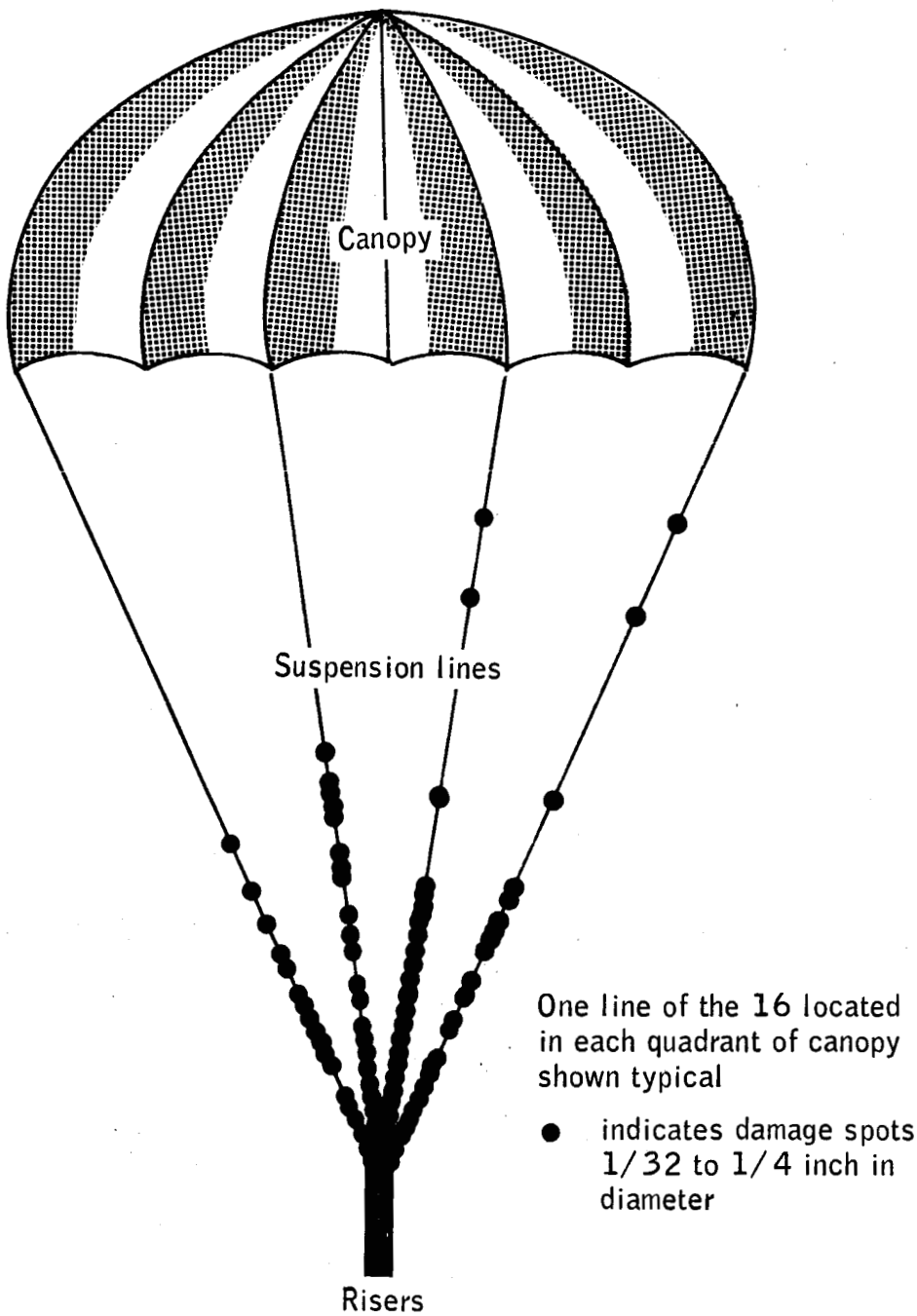


Figure 5.- Typical suspension line damage.

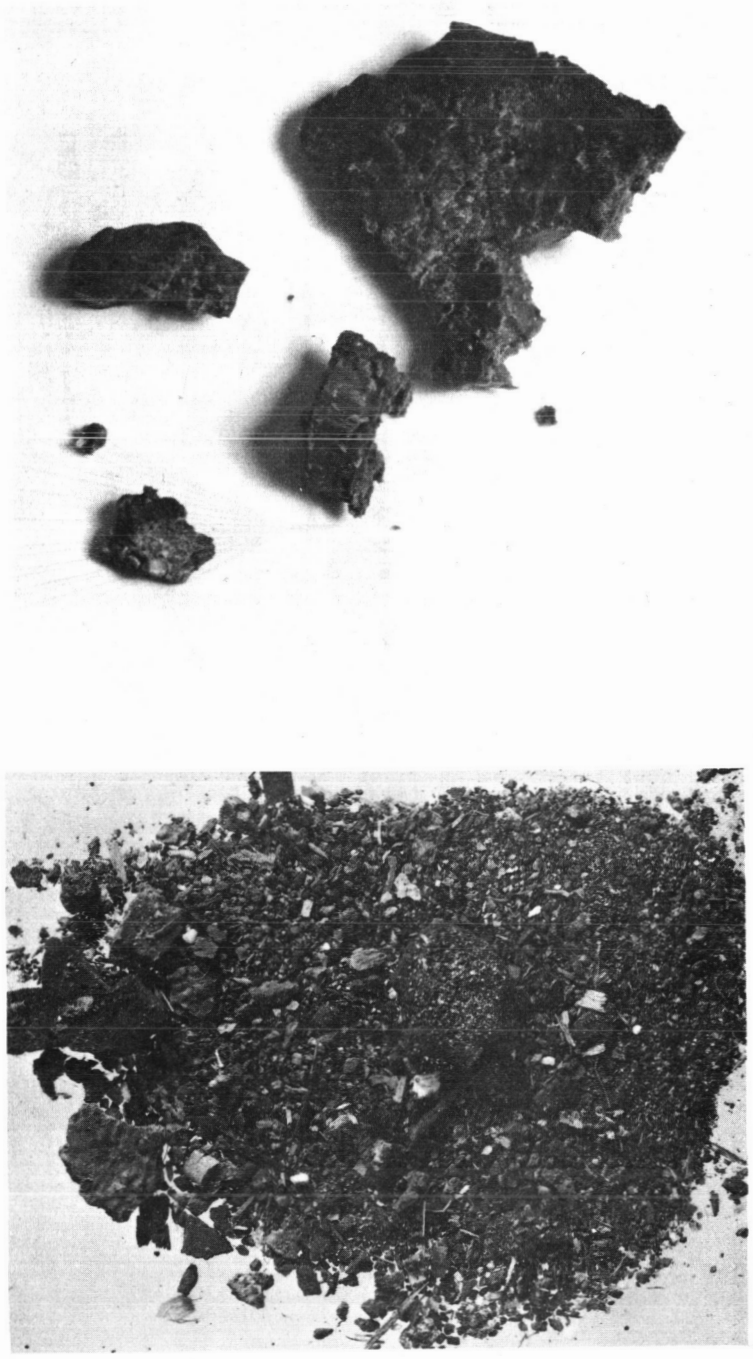


Figure 6.- Foreign material collected from parachute.